People are the Key
HUMAN AND SOCIAL FACTORS OFFICE

HUMAN FACTORS ASSESSMENT OF THE TELIDON AVIATION BRIEFING SYSTEM (TABS): BACKGROUND REPORT

Ontario
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Human Factors Assessment of the Telidon Aviation Briefing System (TABS): Background Report

Prepared by:

Norman Park and Robert Wilson
Norpark Computer Design

Project Manager:

Robert M. Rosenbaum
Human and Social Factors Office

Prepared for:

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Communications Division

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This report is a review of background information that was prepared to support the subsequent studies forming the human factors assessment of TABS. While its use is limited, it may be of interest to anyone with a special interest in weather information systems.

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Table of Contents

1.0 Executive summary

For pilots to operate their aircraft safely and efficiently, they must anticipate weather conditions. In Canada, two weather information services, Atmospheric Environment Service (AES) and Flight Service Stations (FSS), provide weather briefings to pilots, either over the phone or in-person.

A new weather information service called the Telidon Aviation Briefing Service (TABS), now undergoing a two-year trial in southern Ontario airports, enables pilots to learn about weather conditions by using a terminal linked to a central computer.

This background report is the first of a series of studies that will comprise a human factors assessment of TABS. An important objective of the overall assessment is to determine to what extent TABS can provide weather information as a supplement to the other weather information services. This study compares TABS with two of these services, the FSS telephone service and the AES telephone service. In the process this study will determine how the three services operate and what information they provide.

The two objectives of this report are: 1) to summarize the currently available information relevant to a human factors assessment of TABS; and 2) to identify gaps in this information that must be filled in order to complete the human factors assessment of TABS.

The report consists of five chapters. Chapter 2 presents the background necessary to understand the project. Chapter 3 describes the conceptual framework and outlines the assessment issues for a human factors assessment of TABS. The assessment of TABS focuses on the user,

and in particular examines: 1) the current use of TABS and the attitudes of pilots toward it; and 2) the behavior of the pilots who use weather information systems, particularly how accurately and thoroughly they understand weather information after they have used such a system.

Chapter 4 describes the approaches used in this report to examine TABS and the other briefing services. The following operational characteristics of the services were studied: the nature of the pilot-system interaction, the accuracy of the information provided, the availability of the service, the time required to obtain a briefing, the information available from each briefing service, and the types of pilots who use these services.

Chapter 5 describes the findings of this study in detail; conclusions are summarized in chapter 6 as follows:

- There is a real need for a supplement to the currently available weather information service for pilots.
- The three weather information services investigated in this report, AES phone-in, FSS phone-in, and TABS, all appear to provide the same basic weather information. TABS, however, has a number of unique features. These include: 1) Pilots can proceed at their own rate using TABS. They can review previously presented material, look up the meanings of symbols and abbreviations.

  2) Pictorial information can be displayed on TABS. Unlike the AES and FSS phone-in services, TABS can display pictorial information such as maps and graphs. This may make it easier

for pilots to understand weather conditions.

- TABS is also being used to supplement existing weather services. Some pilots use it for training purposes and to plan hypothetical flights. Others use TABS to get a preliminary briefing before phoning one of the other services for a full briefing. TABS also supplements the phone-in services by providing an airport-located backup if pilots cannot reach a briefer by phone.
- There is concern about the accuracy and especially the timeliness of the information in the TABS data base. This is a serious matter because of its safety implications; it also may reduce confidence in the service.
- In some cases there have been problems keeping TABS terminals operational at the airports.
- All weather briefing services appear to experience considerable variability in demand. This variability makes it desirable to design and manage a system that can respond to variations in demand in a flexible, but cost-effective manner.
- Weather information services should give pilots the information they need quickly.
- Pilots use weather information services for a variety of reasons. These include: training, route briefings (most frequent), preliminary briefings, weather updates and area briefings. Each reason requires providing different information. Thus, weather information systems need to be sufficiently flexible so that pilots can obtain needed information

efficiently.

- There is wide variability in the experience and qualifications of pilots. This variability appears to affect the nature of the interaction between the pilot and the system.
- Most pilots do not find it very difficult to use the TABS terminals. Rather the problems of pilots may center around their inability to understand the weather information they are presented and understand its relevance to their planned flight.

Chapter 6 also identifies information gaps that remain at the completion of this study; specifically:

- Very little is known about the pilots who currently use TABS and the other briefing services.
- More information is required related to pilots' reactions to various weather briefing services.
- It is also not known whether pilots thoroughly and accurately understand and remember weather conditions after briefing themselves using TABS.

2.0 Introduction and background

For pilots to operate their aircraft safely and efficiently, they must anticipate weather conditions. In Canada, two weather information services, Atmospheric Environment Service (AES) and Flight Service Stations (FSS), provide weather information either over the phone or in-person.

A new weather information service called Telidon Aviation Briefing Service (TABS), now undergoing a two-year trial in southern Ontario airports, enables pilots to learn about weather conditions by using a terminal linked to a central computer. Weather information is retrieved through a series of menus or the use of keywords.

TABS was developed in response to the tremendous increase in demand for weather information from pilots resulting from a ten-fold increase in the number of airplanes since 1952. As of August 1983, there were approximately 25,000 airplanes in Canada, of which about 6,000 were in Ontario.

The Toronto region in particular has an especially large volume of aircraft traffic. Within 30 nautical miles of Toronto there are 4,000 pilots, 1,100 aircraft, and 41 aerodromes or airports. At these airports there are an estimated 1,100,000 movements (take offs and landings) annually, of which 400,000 are itinerant (the plane does not return to its home base).

Norpark Computer Design Inc. was asked to conduct a human factors assessment of TABS. An important objective is to determine to what extent TABS can provide weather information as a supplement to the other weather information services. Two of these services, the FSS telephone service and the AES telephone service will be examined to determine how

they operate and what information they provide. This project is being done in two stages. This report is being prepared at the completion of stage 1 of the human factors assessment of TABS.

The objectives of this report are:

- To summarize the currently available information relevant to a human factors assessment of TABS.
- To identify gaps in this information that must be filled in order to carry out the human factors assessment of TABS.

The report consists of the following chapters. Chapters 2 through 4 present the background necessary to understand the project, present the conceptual framework and describe the assessment issues, and indicate the methods used in stage 1 to collect the data.

Chapter 5 presents the findings from stage 1. First, the operational and functional characteristics of TABS, the phone-in FSS service, and the phone-in AES service are described. Then the information present in each of these weather information systems is outlined. Also included in this chapter is a description of pilots and the airport sites where the TABS terminals are located. Chapter 6 draws conclusions and identifies gaps in our knowledge where information needs to be collected.

3.0 Conceptual framework and assessment issues

When conducting a human factors assessment of an information system it is important to evaluate the system from the standpoint of the user. Failure to take into account the attitudes, needs, and knowledge of the user can result in the development of a system that is not used and is judged a failure (e.g., Lucas, 1975; Ginzberg, 1981; Kantowitz & Sorkin, 1983; Keen & Meyer, 1979). This outcome is particularly likely to occur if the user has a choice about using the system, that is, if the system is used at the discretion of the user. Examples of such systems include office automation systems (Bikson & Gutek, 1983; Grusec & Park, 1984; Park & Freedman, 1984), decision support systems (Keen & Morton, 1978), and the TABS system being assessed in this project.

Our assessment of TABS focuses on the user, and in particular examines: 1) the current use of TABS and the attitudes of pilots toward it; and 2) the behavior of pilots who use weather information systems, particularly how accurately and thoroughly they understand weather information after they have used such a system.

3.1 Current use and attitudes

It is important to understand the attitudes of the pilots toward the different weather information systems because these attitudes affect whether pilots will obtain weather information before flying. We found that it is commonly believed that many pilots risk their lives and endanger the safety of others by failing to obtain this information before taking off. In one study, conducted before the installation of TABS, it was estimated that less than 50% of pilots wanting weather information

used the services then available. Our preliminary investigations suggested that some pilots do not use weather information systems, in part, because of the way these systems work.

Therefore, we collected available information on characteristics of the weather information systems that seem to influence the decision to use the system. These attributes are:

- The pilot weather information system <u>interaction</u>. The existing telephone services rely on interpersonal communications, while TABS involves human-computer interaction. Some implications of this difference can be explored with existing information. For example, some informants suggested that inexperienced pilots may be reluctant to use the existing services and do not ask questions even though they may not fully understand the information they have been given. On the other hand, some informants suggested that experienced pilots found it reassuring to be receiving weather information personally from experts.
- The <u>accuracy</u> of the information in the data bases and the mechanisms for updating that information. Our informants (individuals knowledgeable about aviation) were concerned that presenting inaccurate or out of date inforamtion to pilots, in addition to being a serious safety hazard, would undermine the credibility of the system.
- The <u>availability</u> of the weather information services. A number of informants indicated that existing telephone weather information services were not being used because the lines

were often busy. The lack of availability of TABS at the present time seems to be more likely to result from technical problems in transmission or at the terminal.

- The <u>time</u> to get needed information. Several pilots indicated that it took too long for them to get the information they wanted.
- The <u>information available</u> from each weather information system. In order to be able to compare the different weather information systems, and because TABS is the primary focus of the project, the information available on the different TABS pages was used to categorize the information in each weather information system.

3.2 Importance of behavior

It is particularly important to know how accurately pilots understand and remember weather conditions after using TABS. If pilots fail to understand or remember the weather conditions, they will be more likely to make a mistake that would affect their safety and the safety of others.

Recently Card, Moran and Newell (1983) showed that the behavior of a person using a computer can be understood by assuming that the user is trying to achieve an objective as effortlessly and easily as possible within the constraints of his knowledge and his processing capacity. A pilot using the TABS system wants information about the weather conditions. To get that information he needs to know about the computer system and about meteorology as it relates to aviation, that is, task structure knowledge. This straightforward analysis suggests that the pilot's

behavior can be understood by examining his goals, his model of the computer system, and his model of the task structure. In addition, we must try to understand the variability in the people using these systems. Presented below is a brief elaboration of these issues, all of which combine to affect the likelihood that a pilot will correctly anticipate weather conditions during a flight.

- User's goals. What are the objectives of users when they are interacting with the system? Why do pilots use weather information systems? What information do they want?
- User's model of the computer system. How does the user conceptualize the computer system? (From the standpoint of the user, the computer system is any part of the computer that the user comes into contact with -- either physically, perceptually, or conceptually. This definition includes all documentation, training material, etc. that the user is given.) How completely do pilots understand the TABS system? Do they understand how to use menus? Are they aware of the keyword page retrieval system? Do they find the documentation and HELP features useful?
- User's model of the task structure. What is the user's understanding of the task environment? What do pilots know about the weather? How accurately and thoroughly do they understand the weather information? Can they read and understand weather maps?
- Variations among users. It is important to identify the users who have different information needs, perhaps because

they have different objectives or different levels of knowledge. Do experienced, highly qualified pilots and inexperienced pilots with minimal qualifications differ in the way they need to have weather information presented, do they require different information to plan their flight activities?

In summary, this report is based on information available on the use of TABS and attitudes of pilots toward TABS and the other weather information services. To understand why many pilots do not obtain weather information before flying, information was collected on the characteristics of the weather systems that seem to influence the decision to use the system. These include: the interaction between pilots and weather information systems, the accuracy and availability of the weather information from the services, the time it takes to obtain that information, and the information available from each weather service. Information was also collected about the pilots goals, their model of the TABS computer system, and their understanding of meteorology as it relates to aviation.

4.0 Approaches used to study the assessment issues

4.1 Operational characteristics of the TABS, FSS, and AES weather information services

4.1.1 Nature of pilot-system interaction

For TABS, this information was collected by using the system, by observing others using it, from a user survey, and from computer-collected usage statistics. For the other two systems, this information was collected during interviews and on-site inspections.

4.1.2 Accuracy

The accuracy of TABS was evaluated by examining a monitoring study initiated by Environment Canada, by interviewing people involved in that study, and by interviewing pilots who have used the system. The monitoring study had briefers compare pages on TABS to information on the AES weather information system to determine whether the information on TABS was available, and how accurate, and timely it was. The TABS system was monitored several times a day, with the briefers deciding whether each page was acceptable or not acceptable.

According to AES, caution should be exercised when using this information because the main purpose of this monitoring study was to demonstrate its feasibility rather than to collect data. It is our understanding that the monitoring study is now being done more systematically by an organization under contract to AES.

4.1.3 Availability

Availability of TABS was established through interviews, visits to airports where TABS terminals are located, and the AES monitoring study just described.

Information regarding the availability of the FSS came from interviews and from a study of telephone usage, "the FSS busy study." In this study, usage of the FSS inwats line (800) 268-4877 was monitored for the month of April 1984. Among the data collected in this study were the number of calls completed, the duration of these calls, and the number of calls attempted but not completed.

Information on the availability of the AES service came from interviews and from a telephone usage study, "the AES busy study." The study monitored usage of the AES telephone lines on July 3-6 and 9-13 1984 between 6 a.m. and 9 p.m., and later on December 3-7 1984. Results were presented in a highly aggregated form making it a somewhat less useful study for this project than the FSS busy study.

4.1.4 Time involved to get weather information

The time involved to get information from FSS was obtained by interviewing FSS personnel and from the FSS busy study. For AES, it was obtained by interviewing AES personnel. For TABS, the time was estimated by using the system and measuring how long it took for various pages to be displayed.

4.2 Information available from each weather information system

The information available from TABS was determined by using TABS and from

the following background documentation: a proposal titled "Telidon Aviation Briefing System implementation for the Toronto area trial" written by Meteorological and Environmental Planning Limited, December 1983; and a document titled "Telidon Aviation Briefing Project - Toronto area trial system functional specification", August 1983.

The information available from the FSS and AES phone-in services was determined by on-site visits and interviews with briefers and management.

4.3 Pilots

Information about pilots was obtained by interviewing pilots and a number of people who are in close contact with pilots such as instructors at airports and Community Colleges and personnel at Transport Canada concerned with matters such as pilot training and aviation safety.

An additional source of information was a survey done by Transport Canada in cooperation with the government of Ontario and the Atmospheric Service, which asked pilots about their use of TABS and other weather information systems. This survey was administered by placing copies of the questionnaire near the TABS terminals located at airports and encouraging pilots to complete the form. Care should be exercised when interpreting the results of this survey because there are reasons to believe that the people who filled in the survey were more likely to be experienced pilots. However, the survey is useful in that it gives a preliminary indication of pilots' reactions to TABS.

4.4 TABS terminal sites

Information about the TABS terminal sites was obtained by interviewing people at the sites who were familiar with the airport, flying, and TABS. In addition, patterns of usage were investigated by examining system usage data collected by the TABS mainframe computer.

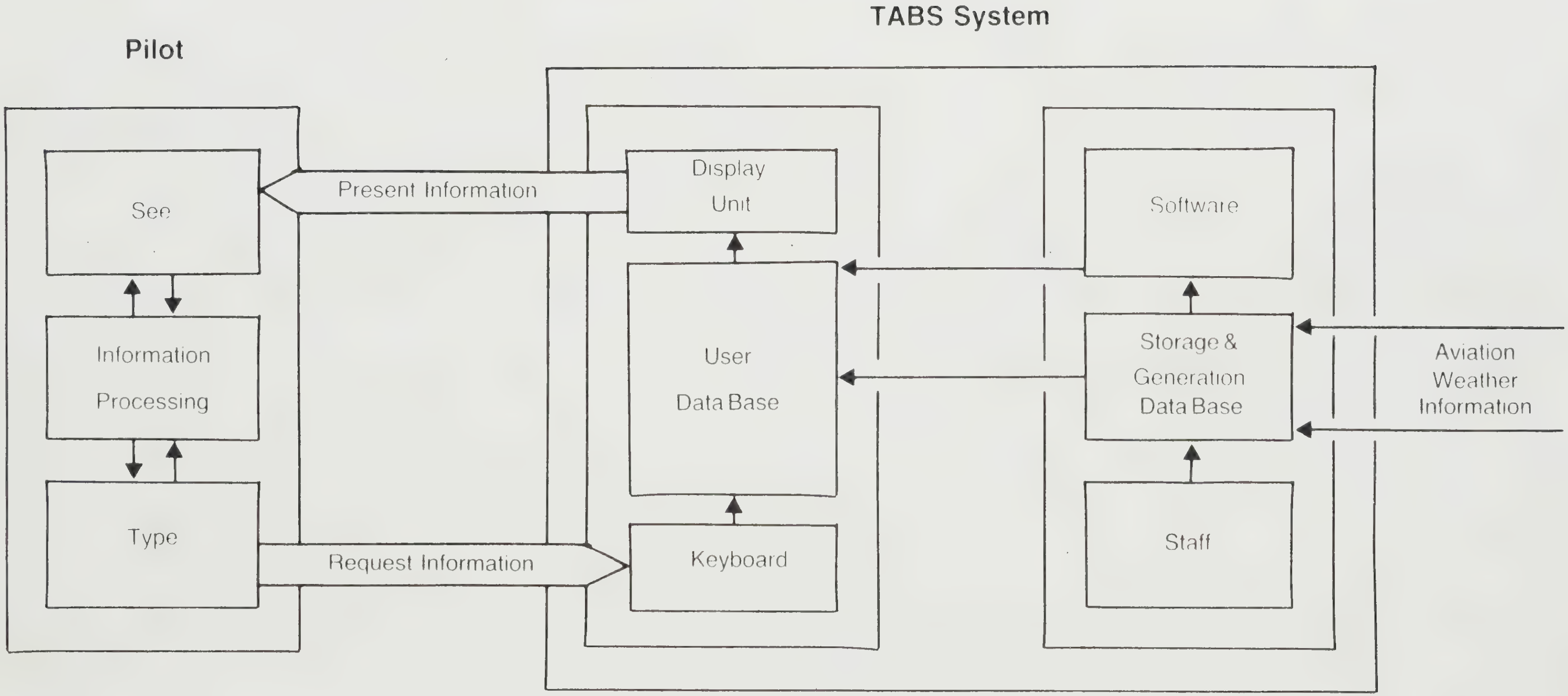

Figure 1. Schematic diagram of self-briefing as provided by the Telidon Aviation Briefing System.

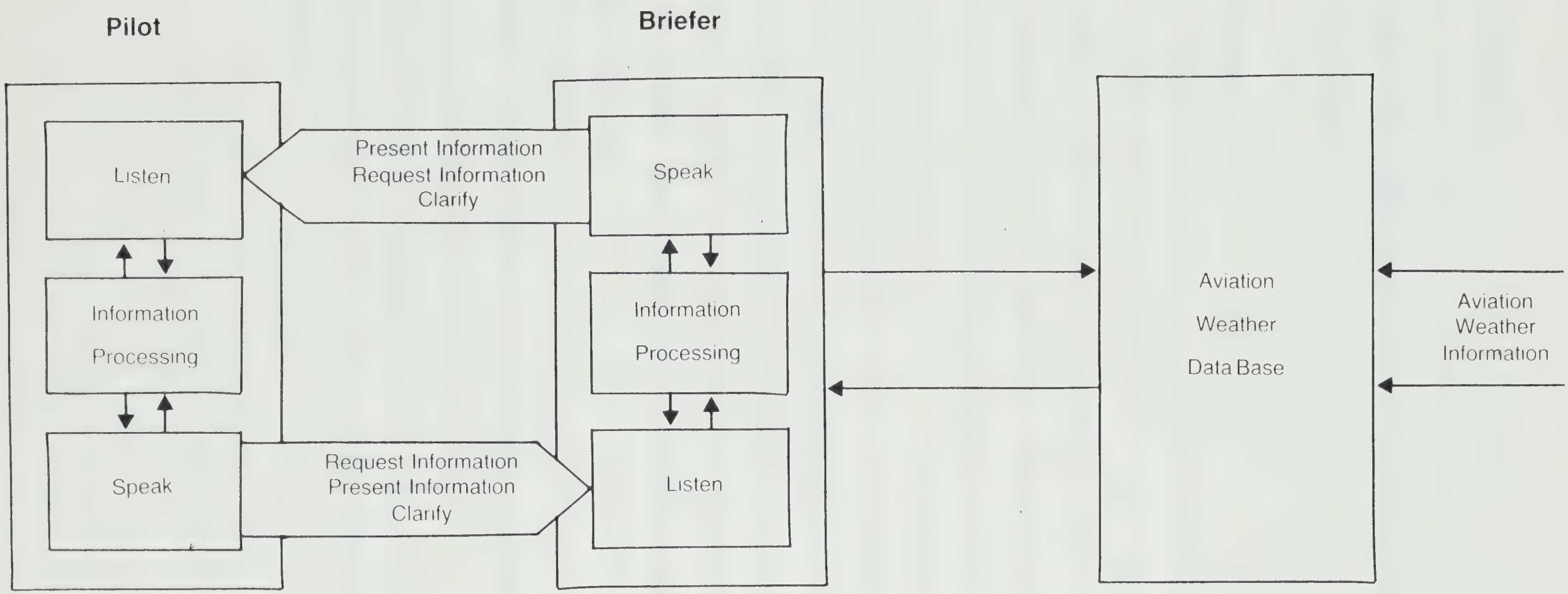

Figure 2. Schematic diagram of telephone briefing as provided by staff of Atmospheric Environment Service and Flight Service Stations

5.0 Findings

5.1 Operational characteristics of FSS, AES, and TABS weather information system

5.1.1 Overview

Figure 1 represents schematically the pilot-TABS system. The pilot subsystem is represented in the left side of that figure. Information from the terminal is perceived, it is processed, decisions are made, and then motor responses are made. These motor responses may result in the pilots writing down some information or using the keyboard to request different information.

The right side of figure 1 represents the TABS system. The terminal (with a color monitor) is connected to the mainframe with the TABS user data base. Information in this data base comes directly from the storage and generation data base, or it is modified by software before entering the user data base, or it is manually modified before entering the user data base.

Telecommunication lines feed the storage and generation data base with notice to airmen (Notams), weather maps from AES facsimile machines, and textual information also supplied by AES.

The information is stored in the form of Telidon pages that are continually being updated. These pages contain textual and graphic information.

5.1.2 Nature of the pilot-TABS interaction

The pilot gains access to information either by using keywords or a series of menus. Pilots indicated that they did not have difficulty using the menus. A few pilots said that they would like to get to TABS pages directly, indicating that they were unaware of the keyword access facility. The pages are organized into a tree structure (e.g., Shneiderman, 1980). The tree consists of only a few levels and, for this reason, we expect that pilots will experience less serious problems than users of multiple-level tree structured indexes. In the latter situation, problems include: not knowing whether sought-after information is present in the data base, not knowing where to look for it (e.g., Phillips, 1981), and frustration at having to proceed through several levels of the data base to find the needed information (e.g., Robertson, McCracken, & Newell, 1981).

There are two different ways a pilot can obtain weather information using TABS. If the pilot wants a fairly complete briefing about weather conditions, he can choose option 1 on the Welcome page and will be shown the following pages (the pages are more fully described in section 5.2): Sigmets, surface analysis, surface prognosis, FA T+0, FA T+12, FAs for southern Ontario, north central Ontario, and Ottawa/Quebec regions, VFR/-IFR prognosis, VFR/IFR analysis, Pireps, and SA/FTs.

If a pilot selects option 1, he is "locked into" the sequence of pages described above and must view those pages in a prescribed order. The only way the pilot can escape from that sequence is to exit from the session and to log on again. At the end of the structured briefing the viewer is shown the main menu of the TABS program.

The second way a pilot can use TABS is by deciding what information he needs and selecting the TABS pages containing that information. To operate this way the pilot selects option 2 on the Welcome page.

5.1.2.1 Pilot-FSS and pilot-AES system overview

Figure 2 represents the pilot-FSS (or AES) system. The left side of the figure once again represents the pilot subsystem and the right side presents the FSS or the AES subsystem. Unlike the pilot-TABS system, where the pilot interacts directly with a computerized data base, when the pilot telephones either the FSS or AES, he talks to an intermediary (a briefer) about his information needs. When the briefer understands these needs, he or she decides what information the pilot requires, retrieves the necessary information from the weather information data base, and gives over the telephone a presentation of the weather information requested in a form that is designed to be organized and understandable.

There are a number of differences between the FSS and AES systems. A detailed examination of these differences is beyond the terms of reference of this project. However, it is clear that the user interface between the briefer and the weather information data bases is quite different in the two cases, that the information contained in the two data bases is different, and that the responsibilities and training of the briefers are different.

5.1.2.2 Nature of the pilot-briefer interaction

At this point, we have only a rudimentary understanding of the pilot-briefer interaction. However, we have been impressed by how varied that interaction can be. Some pilots, especially those who are highly experienced, like to control the dialogue. They have very specific information requirements, and may resist attempts by the briefer to introduce information they have not requested. Other pilots, often those who are less experienced, want the briefers to control the dialogue and tell them the information they need to plan their flight.

A second characteristic of the pilot-briefer interaction is that briefers often respond differently to highly experienced and new pilots, modifying the speed and level of information presented to new pilots so that they are better able to understand the briefing. One of the potential problems with this flexibility is that some new pilots masquerading as experienced pilots may fool the briefer and get a briefing intended for an experienced pilot. This briefing may be difficult for a new pilot to understand.

Third, briefers also respond to a wide variety of different requests for information which vary from long, detailed area briefings, to a short update on the current weather conditions at a particular airport. Also, briefers who know what route a pilot is planning are flexible in their responses, providing only the weather and related information relevant to the planned flight.

An additional characteristic of the pilot-briefer interaction has to do with the division of responsibility between the briefer and the pilot. The briefer is responsible for providing weather and related

information in an organized and understandable fashion to the pilot. The pilot is responsible for communicating his weather information needs and for making decisions about his flight. It is within the mandate of the briefer to point out weather conditions that present a hazard to a planned flight, although the pilot has ultimate responsibility for the flight and may choose to ignore the information supplied by the briefer. Thus, by informing a pilot about hazardous weather conditions that the pilot did not seem to take into consideration, briefers may act as a safety net. According to our informants, briefers perform this function infrequently, on average perhaps once or twice a month per briefer. However, because of the important safety implications, this sort of interaction between the briefer and pilot should be kept in mind.

5.1.3 Accuracy and timeliness of the information

5.1.3.1 TABS

Data that can be used to assess the accuracy and timeliness of the information on the TABS computer system comes from a study by AES which monitored the information in the TABS data base several times a day during August, October and November 1984.

The results of this monitoring are summarized in table 1. The leftmost column lists the different TABS pages. To the right of each page are the number of times the page was found to be not acceptable (N/A) and the total number of times the page was monitored (TTL) for the months of August, October, and November. The three right-most columns present the total number of times for the three-month period that the

page was unacceptable, the total number of times the page was monitored, and the percentage of not acceptable pages (% N/A).

These data seem to indicate that:

- there are problems with the acceptability of information in the TABS data base. Over a three month period, 25% of the pages monitored were not acceptable.
- these problems are chronic and recur from month to month. The overall percentage of unacceptable pages during the three month period ranges from about 19% in August to 31% in November. Furthermore, inspection of the unacceptability of the pages from month-to-month indicates that certain pages seem more likely to be unacceptable. Those pages found to be unacceptable on average more than 30% of the time are Radar (SD), Cross-sections, Aerodrome weather (SA/FTs), Surface analysis, Surface prognosis and VFR/IFR analysis. The content of these pages is describe in section 5.2.

The AES personnel involved in the monitoring study indicated that the most frequent reason for unacceptability was that the information in the TABS data base was not up to date.

To summarize, the results of this study suggest that there are problems keeping the information in the TABS system up to date, and these problems are more serious for some pages.

Acceptability of TABS pages for 3 months

Page Name	August N/A	August TTL	October N/A	October TTL	November N/A	November TTL	Total N/A	Total TTL	Total %N/A
Sigmet	1	111	0	107	4	125	5	343	1
SFC Current	20	82	35	72	34	92	89	246	36
SFC Prog.	17	78	33	72	36	93	86	243	35
SIGWX T+0	19	102	9	90	26	96	54	288	18
SIGWX T+12	28	109	23	90	32	94	83	293	28
FAs	14	99	7	90	16	93	37	282	13
VFR/IFR Prog.	30	117	7	87	10	77	47	281	17
VFR/IFR Anal.	11	91	30	92	56	123	97	306	32
Pireps	9	121	14	105	29	129	52	355	15
SA/FTs	37	118	44	111	57	132	138	361	38
SDs	52	119	116	116	141	141	398	376	82
Radar	0*	105	6	104	10	128	16	337	5
850 mb	9	80	3	65	11	70	23	215	11
700 mb	6	80	3	65	9	69	18	214	8
FDs	12	85	5	68	7	86	24	239	10
XSC	39	103	28	91	49	97	116	291	40
Notams	11	75	0	59	2	59	13	193	7
	315	1675	363	1484	529	1704	1207	4863	25

Table 1

5.1.3.2 AES and FSS

Although there is no reason for thinking that the AES or FSS information is inaccurate, we are unaware of any studies that have examined this question.

In addition to monitoring the accuracy and timeliness of the information in the data bases, it is also necessary to determine how accurately AES and FSS briefers describe weather conditions. No information capable of answering this question appears to exist. One difficulty in collecting data on briefer accuracy is that it would require monitoring phone calls between the briefers and pilots and this could infringe on

* Data never available.

their rights to privacy.

In an interview with FSS personnel, it was learned that the phone conversations of the briefers are audiotaped and evaluated from time to time. However, these evaluations are done primarily to ensure that the service offered by FSS is accurate and of high quality and the data have not been systematically collected and analyzed.

5.1.4 Availability

This section describes the factors affecting how easily users can gain access to the different weather information systems.

5.1.4.1 TABS

The factors that reduce the availability of TABS are in part attributable to the fact that TABS is a new service being tested. One factor is that the TABS terminals are available to pilots only at airports. In the future, it is technically possible to make the service more easily available by allowing people with appropriately equipped microcomputers to gain access to the data base. A second factor reducing availability is that the service is currently available from 6 a.m. to 8 p.m. Based upon the FSS busy study, these hours of service probably are adequate for all but about 8% of the requests for information. However, results from the user survey indicate that some pilots flying at night find this a limiting aspect of the TABS. A third factor is that some of the terminals at the airports do not work reliably. This results in short-term unavailability of TABS and may also discourage pilots from relying on the system.

The important factor enhancing availability is that if the terminal is functioning properly TABS is almost always available for use during its scheduled hours. According the the AES study monitoring TABS, the computer system is functioning properly at least 95% of the time. In addition, our information indicates that at current usage levels, pilots are able to use TABS immediately and are not placed in a queue or told to try some later time.

5.1.4.2 FSS

Factors enhancing the availability of the FSS weather information phone-in service are first, that there is a free inwats line to use 24 hours a day and second, pilots can use the service almost anywhere because telephones are so widely available.

The important factor reducing the availability of this service is that the phone lines to FSS are often busy. The user survey and interviews with pilots indicate that this factor discourages pilots from using FSS briefings.

A busy study of the FSS inwats line confirmed that the telephone lines are frequently busy. Results from this study showed that on average only 41% of calls placed were completed. In other words, more than half the time there is a busy signal when a pilot calls.

There is considerable variability in the likelihood of a pilot successfully completing a phone call to the FSS. If a pilot phones during off-peak hours, between 1 a.m. and 5 a.m. or after 4 p.m., the call will be completed about 66% of the time. Unfortunately, few pilots need weather information during those hours. When they need weather informa-

tion during the day, their chances of completing a phone call are about 30% and, during the worst hour of the day, dip to 19%.

There is also considerable variability from day to day in a month. During April, the month of the survey, the number of phone calls made per day averaged 93.27 but ranged from a minimum of 35 to a maximum of 205 calls. Since this system (and AES) is close to capacity at certain times, marginal weather has the unfortunate effect of reducing availability at the very times when it is most needed.

5.1.4.3 AES

Like the FSS service, AES is easily available in Toronto because it is a 24 hour-a-day phone-in service but once again, pilots indicated that the AES phone lines are frequently busy.

Results from busy studies on the AES telephone lines confirm the comments made by the pilots. One study, conducted in July 1984 found that during the busiest hour of the day, the lines were busy on average 33 minutes per hour. A second study conducted in December 1984 found that during the busiest hour the lines were busy for 26 minutes. Taken together these two studies indicate that the AES lines are busy about half the time.

5.1.5 Time to get weather information

5.1.5.1 TABS

The duration of a TABS briefing session consists of the time it takes to sign onto the computer system, plus the time it takes to display and read the TABS pages.

Barring problems, it takes about 45 seconds to sign onto the system. The time pilots spend interacting with TABS once they have signed on is shown in table 2. It presents the frequency distribution of the duration of TABS sessions for the first and last 7 days of October. As this table shows, TABS sessions are reasonably brief; 54% of the sessions lasted 6 minutes or less, with the median session duration of 5 minutes (the median is a better estimate of central tendency than the mean (7.8 minutes) because the frequency distribution is asymmetrical and skewed to the right).

Table 2 was constructed from computer-recorded data by considering only sessions from the terminals used by pilots, and including a session only if the terminal was unused in the previous and succeeding hour of the day. This last condition was included to reduce the likelihood of overestimating session duration by including in the count a session involving more than one pilot.

We also measured how long it took to retrieve and display pages in a structured briefing. The minimum time required was approximately 5.25 minutes. This rough estimate does not include the time pilots would spend reading the information, but we estimate that very few pilots spend more than a total of 10 minutes in a structured briefing session, an

estimate which is consistent with results in table 2.

Length of TABS sessions in October 1984

Duration of session (min)	Percentage of sessions Oct. 1-7 N=166	Percentage of sessions Oct. 25-31 N=158	Percentage of sessions Average N=324
0.1-2.0	26	23	24
2.1-4.0	18	18	18
4.1-6.0	14	10	12
6.1-8.0	8	6	7
8.1-10.0	9	17	13
10.1-12.0	5	6	5
12.1-14.0	3	4	4
14.1-16.0	3	2	2
16.1-18.0	7	3	5
18.1-20.0	2	1	2
20.1-30.0	3	6	5
30.1 or more	2	4	3
	100	100	100

Table 2

Table 3 presents the time that elapsed between the receipt of the request for a page and the transmission of the last piece of information of that page. These data represent results from only a single day and therefore provide only a rough estimate of display times because the time to display some pages varies widely from day to day depending upon the complexity of the weather conditions being described.

Table 3 shows that it takes an average of 33.47 seconds for a page to be displayed, although the display times vary from 7 seconds for pages with text to 75 seconds for pages with graphics.

Approximate length of time for TABS pages to be displayed on screen

Page Name	Time for page to display (sec)	Comments
Sigmet	20	there were 2 Sigmet pages
Surface analysis	65	
Surface prognosis	60	
FA T+0	35	
FA T+12	30	
FA	25	includes time to get regional map
VFR/IFR prognosis	15	
VFR/IFR analysis	25	
Pireps	7	no Pireps when time recorded.
SA/FTs	20	includes time to access aerodrome.
SDs	12	includes time to get specific weather information.
Radar	20	almost a clear screen.
850 mb	75	
700 mb	65	
FD	20	2 screens.
Cross-section	20	clear skies.
Notams	55	2 screens.

Table 3

In conclusion, pilots typically spend a total of 6 minutes using TABS to get weather information; about 45 seconds of this time is spent signing on and the remaining time is spent getting weather information. Some pilots in the user survey suggested that the sign-on procedure should be streamlined and take less time. This comment is understandable because a sign-on time of 45 seconds is often very substantial in comparison to the time spent actually getting information from TABS (see table 2), which is often less than 5 minutes. For similar reasons it is understandable why some pilots want pages displayed more rapidly.

5.1.5.2 FSS

To determine how long it took pilots to obtain weather information, the informants at FSS were asked to identify the different types of briefings they had with pilots, to estimate what percentage of their calls were of each type, and to estimate how long on average each of the different types of briefings took. The informants identified the following types of briefings (rough estimates of the percentage of briefings of each type in brackets): structured weather briefing (50%), partial weather briefing (20%), filing a flight plan (20%), and reading the notice to airmen, Notams (10%).

Informants indicated that the average time it takes to give a structured weather briefing to an experienced pilot varies from about 3 minutes when the weather is good to about 10 minutes when the weather is very poor. For new pilots, these times are somewhat longer, ranging from about 7 minutes for good weather to 12 minutes for marginal weather, and 2 minutes for very poor weather. (New pilots are unlikely to fly when the weather is very poor). Filing a flight plan was estimated to take about 2 minutes, it takes a minute or two to give a partial weather briefing (e.g., an update, or a preliminary overview of the weather) and relevant Notams. In summary, most of the pilot-briefer interactions take only a few minutes. Seldom do they take more than about 7 minutes.

These results are consistent with data shown in table 4. This table shows the percentage of calls of different lengths and is based on a total of 191 calls. These data were obtained from the FSS busy study by counting only those phone calls from a particular phone number where only a single call had been completed and measuring the duration of that

phone call. Not included were the data from phone numbers where multiple calls had been completed because the total duration of the calls was given, not the individual call durations. Because of the selection procedures used, it is possible there is a sampling bias. To examine this possibility, the weighted average duration of the calls shown in the table (3.3 minutes) was compared to the overall average duration (3.12). The difference in average duration (.18 minutes) or about 11 seconds is small suggesting the data in the table may be representative of all the phone calls received by FSS.

The results from this table confirm that most pilot-briefer interactions are brief -- 78% of the calls take 4 minutes or less to complete, and only 8% take more than 8 minutes to finish. In conclusion, pilots typically spend less than 4 minutes getting weather information, once they have gotten in touch with a briefer. However, we do not know how long it takes to reach an available briefer, although the busy studies indicate that it can be a considerable length of time. Similar considerations apply to the AES telephone services.

Percentage of calls of varying duration to FSS

Duration of call (in minutes)	% (N=191)
.1 - 2	48
2.1 - 4	30
4.1 - 6	9
6.1 - 8	5
8.1 - 10	2
10.1 - 12	2
12.1 - 20	2
20.1 and more	2
Total	100

Table 4

5.1.5.3 AES

There is considerable variability in the duration of briefing sessions, but it very rarely takes more that 10 minutes to give to a route briefing to a pilot, a finding consistent with the FSS briefing times.

Unfortunately, the telephone usage studies (busy studies) at AES were so highly summarized that they could not be used to determine the frequency distribution of the duration of phone calls.

5.2 Information available from each weather information system

This section describes the information present on the different weather information data bases. We focused on the information content because in a data base system it is important to know what information is stored. The description of the information in each of the data bases is organized in terms of the content from the TABS pages.

5.2.1 Information available from TABS

A common format is used to describe each page in TABS. First, the name of the page is given. This is followed by the keyword, which is the series of letters permitting direct access to the page when they are typed on the keyboard. For example, to access directly the surface analysis page, one needs to type "SFCA". Next the representation of the information is described; then the frequency of update is noted, the source of the information is identified, and finally the content of the page is described.

5.2.1.1 Sigmets

Keyword: WS.

Representation: Abbreviated text.

Update: As received; no time indicated.

Source: AES circuit 269.

This page is shown at the beginning of a session before the user can access another page. It reports hazardous weather phenomena occurring in Canada. Sigmets for the last four hours are shown in the sequence in which they were received. If a sigmet is received while a user is viewing another page, a message appears superimposed over the page he is viewing.

5.2.1.2 Surface analysis

Keyword: SFCA.

Representation: Map with weather information denoted by meteorological symbols.

Update: 6 Hours; time indicated at the top right-hand corner.

Source: FAC 1801 from Toronto.

AES sends the surface analysis and prognosis maps (2 and 3) by facsimile machine to MEP. These maps are then drawn manually on a page creation system that puts information into Telidon code. They are then added to the MEP data base. The surface analysis map describes current surface weather conditions and the prognosis map describes the forecast conditions 12 hours from the time of the forecast.

The pages consist of a surface weather map of southern Ontario marked for isobars, fronts, middle cloud, precipitation, trowals and

trofs. The prognosis is for 12 hours from the time of creation.

5.2.1.3 Surface prognosis

Keyword: SFCP.

Representation: Map with weather information denoted by meteorological symbols.

Update: 6 Hours; time indicated at the top right-hand corner.

Source: FAC 1801 from Toronto.

5.2.1.4 FA T+0

Keyword: FA0.

Representation: Map, meteorological notation, and abbreviated text.

Update: 6 Hours; time indicated at top right-hand corner.

Source: Derived from the FAs.

5.2.1.5 FA T+12

Keyword: FA12.

Representation: Map, meteorological notation and abbreviated text.

Update: 6 Hours; time indicated at the top right-hand corner.

Source: Derived from the FAs.

The FA pages consist of a map of southern Ontario. The map indicates potential weather hazards and contains a textual description of the weather.

5.2.1.6 FAs

1 - Southern Ontario YYZ1

2 - North Central Ontario YYZ2

3 - Ottawa / Quebec Regions WUL1

Keyword: FA,YYZ1 etc.

Representation: Abbreviated text.

Update: 6 Hours, occasionally amended; the time is embedded in the text.

Source: AES circuit 269.

Consists of the currently valid regional forecast.

5.2.1.7 VFR/IFR prognosis

Keyword: VFRP.

Representation: Map showing shaded regions.

Update: 6 Hours; time indicated at the top right-hand corner.

Source: Derived from the FAs and FTs.

The map consists of a colour contour plot indicating regions of VFR, MVFR, and IFR. Hazards are indicated on the charts. A VFR condition has a ceiling above 3000 feet and/or visibility for farther than 5 miles. An MVFR condition has a ceiling of 2000 feet and/or visibility for 3 to 5 miles. An IFR condition has a ceiling lower than 1000 feet and/or visibility for less than 3 miles.

5.2.1.8 VFR/IFR analysis

Keyword: VFRC.

Representation: Map showing dots over the issuing center.

Update: Hourly; time indicated at the top right-hand corner.

Map for most of Ontario showing the VFR, MVFR or IFR conditions for 28

reporting sites in the Ontario region. Consists of a map of southern Ontario with colored dots indicating the VFR, MVFR, or IFR weather conditions at each issuing center.

5.2.1.9 Pireps

Keyword: UA.

Representation: Abbreviated text.

Update: As received.

Source: AES circuit 269.

Consists of the reports of any unusual weather conditions encountered in flight (e.g., unpredicted thunderstorms, etc.) and received during the last hour.

5.2.1.10 SA/FTs

Contains the SA/FTs for the following issuing centers:

BUF (Buffalo), CLE (Cleveland), YEL (Elliot Lake), YZE (Gore Bay), YHM (Hamilton), YKF (Kitchener), YGK (Kingston), YXU (London), YQA (Muskoka), WMN (Mt. Forest), IAG (Niagara), YYB (North Bay), YOW (Ottawa), YWA (Petawawa), YPQ (Peterborough), YSN (St. Catharines), YZR (Sarnia), YAM (Sault Ste. Marie), YYZ (Pearson International), YTZ (Toronto Island), YTR (Trenton), YSB (Sudbury), YQG (Windsor), YVV (Wiarton). (There is no FT for Mt. Forest.)

Keyword: SA,YQG etc., or FT,YQG.

Representation: Two panels of abbreviated text. The top shows the SA, the bottom the FT.

Update: SA: Hourly, amended by occasional "specials"; time is

embedded in text.

FT: 6 Hours, occasionally amended.

Source: AES circuit 269.

An SA is a surface aviation weather report which describes current weather conditions at an aerodrome. An FT is an aerodrome forecast. It indicates weather factors that are important during take off and landing at an aerodrome.

5.2.1.11 SDs

1 - YXU - London (Exeter)

2 - YYZ - Toronto (King City)

3 - YOW - Ottawa (Carp)

4 - YQB - Montreal (Villeroy)

5 - WYB - North Bay (Britt)

Keyword: SD,YXU etc.

Representation: Abbreviated text.

Update: Daily, or every 10 to 12 minutes when precipitation echoes.

Source: AES circuit 269.

Consists of the latest information determined using surveillance radar. This radar can locate areas of precipitation and convective type storms. Messages older than 1 hour are deleted.

5.2.1.12 Radar

Keyword: RAD.

Representation: Depiction of a surface level radar screen.

Update: 10 to 12 minutes; time indicated at the bottom left corner.

Source: King City Digitized Radar.

Consists of the latest surface level radar display which is less than 1 hour old.

5.2.1.13 850 mb chart

Keyword: 850M.

Representation: Map.

Update: 12 Hours; time indicated at the top right-hand corner.

Source: FAC 1801 from Montreal.

5.2.1.14 700 mb chart

Keyword: 700M.

Representation: Map.

Update: 12 Hours; time indicated at the top right-hand corner.

Source: FAC 1801 from Montreal.

Map of mainland USA and Canada; 850 mb and 700 mb charts show reported atmospheric conditions at 850 mb (1500 meters) and 700 mb (3000 meters) such as wind speed and direction, temperatures, etc.

5.2.1.15 FDs

1 - YOW - YYZ - YQG

2 - YAM - YYB - YOW

3 - BUF - YYZ - YYB

4 - YYZ - YVV - YAM

5 - CLE - YQG - YVV

Keyword: FD,YOW,YYZ,YQG etc.

Representation: 3-Column chart.

Update: 12 Hours, seldom amended; time indicated at the top of the table.

Source: AES circuit 269.

Consists of the first 5 levels of upper air winds forecasts (direction, velocity). Retained until the end of the valid period or until replaced.

5.2.1.16 Cross-sections

1 - YYZ - YXU - YQG

2 - YYZ - YTR - YOW

3 - YYZ - YVV - YAM

4 - YYZ - YQA - YSB

5 - YYZ - IAG - BUF

Keyword: XSC.

Representation: Chart.

Update: 6 Hours; time indicated at the top right-hand corner.

Source: Derived from FTs.

Consists of a graphic description of the cross-section along the route, including winds at several levels, frontal surfaces, convective activity, freezing level.

5.2.1.17 Notams

Keyword: NOT.

Representation: Map of Canada showing the regions LE1 to LE9.

1 - LE1

1.10 - General Summary

1.11 - Station ID 1

etc.

2 - LE2

2.10 - General Summary

2.11 - Station ID 1

etc.

...

9 - LE9

9.10 - General Summary

9.11 - Station ID 1

etc.

Representation: Abbreviated text for each Station ID.

Update: As received.

Source: AES circuit 942 (fed by Transport Canada).

Contains all Notam and Notamj messages still in effect for the aerodrome. These messages contain information about the conditions or changes in aeronautical facilities, services, or procedures that are essential to personnel concerned with flight operations. The page is updated as soon as a new message is received.

5.2.1.18 Help

1 - How to Use TABS

2 - SA Directory

3 - SA Decode

4 - FT Decode

5 - Abbreviations

6 - Symbols

7 - SD Decode

Keyword: HELP.

Representation: Text.

This page is available from the Welcome page. It contains information designed to help pilots using TABS. The first choice, How to Use TABS, describes the keyboard and the different types of briefings. The second choice, SA Directory, gives a list of the available SA/FT's. The third choice, SA Decode, describes the information contained in an SA and the fourth choice describes the information in an FT. The fifth choice, Abbreviations, gives a complete list of abbreviations used in aviation weather briefings. The sixth choice, Symbols, indicates what the symbols used in the weather maps represent. The seventh choice, SD Decode, describes the information contained in a radar message.

5.2.2 Information available from AES

The information available to the AES briefers was assessed by using the TABS pages as a basis of comparison.

There is more weather information present in the AES system than on the TABS system. The AES system has broader geographical coverage. It has information about all of North America, the Caribbean, the eastern Pacific region, the Atlantic region and Europe. TABS has information only about current and forecast weather conditions in southern Ontario.

The information on the AES system also tends to be more detailed

than the information available on TABS for southern Ontario because AES not only gets information from airports (like TABS) but also gets information from other observation stations in southern Ontario not available on TABS.

The AES information is also temporally more comprehensive. It has available both the previous weather conditions and maintains longer range forecasts, which can be 3, 4, or 5 days and in some cases seasonal forecasts.

AES also has more complete information about weather conditions at higher altitudes. AES has information at 850 mb, 700 mb, 500 mb, 250 mb, and can obtain information at 100 mb if that information is necessary, whereas TABS only has information at 850 mb and 700 mb.

In addition AES information is more likely to be up to date than the information on TABS.

In summary, the AES data base has a broader geographical coverage, it contains more detailed information, it has information about weather conditions at higher altitudes, the information is temporally more comprehensive, and is likely to have been updated more recently.

There are two types of information on TABS that are not routinely available to those who use the AES service: Notams (notice to airmen), and the cross sectional weather information charts.

Presented below is a brief description of the pages available on TABS and an indication of the type of information available on the AES system.

5.2.2.1 Sigmets

A Sigmet is a warning issued about a potentially hazardous weather condition. AES has access to all Sigmets on TABS, but also includes Sigmets from all of North America, the Atlantic region and the Eastern Pacific region.

5.2.2.2 Surface analysis

The surface analysis map depicts the mainland USA and all of Canada, with the exception of the far north. Presentation technicians get this information from a facsimile. The chart describes the weather using meteorological symbols -- isobars, fronts, precipitation, etc. Color is added by the presentation technicians to make it easier to read. This map, which is pinned to the wall, is used to give the technicians a general idea of the weather conditions. These maps are prepared by AES every 6 hours.

5.2.2.3 Surface prognosis

The comments presented above, describing the surface analysis, also hold for the surface prognosis. However the prognosis gives the weather forecast 24 hours later than the surface analysis.

5.2.2.4 FA T+0 and FA T+12

AES has plan views that give similar information to the information presented on FA T+0 and FA T+12.

5.2.2.5 VFR/IFR analysis and prognosis

There is no directly equivalent information available from AES. However, AES can derive this information by examining the current and forecast weather conditions on a station by station basis. AES can obtain a more detailed idea of VFR/IFR conditions because they have access to a greater number of stations reporting in southern Ontario.

5.2.2.6 Pireps

AES has access older Pireps and has Pireps from the rest of Canada and the USA, as well as those shown by TABS.

5.2.2.7 SA/FTs

AES has SAs (current weather reports for each station) and FTs (aerodrome forecasts) from more stations within the coverage area of TABS, southern Ontario, and broader geographical coverage.

5.2.2.8 SD

SDs (textual descriptions of weather surveillance radar reports) are available on the AES system. In fact, the presentation technicians are responsible for preparing this information.

5.2.2.9 Radar

AES has access to the radar from King City (this is the one that TABS shows), but in addition has access to the radar output from Exeter, Britt, and Carp (Ottawa).

5.2.2.10 850 mb and 700 mb charts

AES has access to the 850 mb and 700 mb levels but also has access to the 500 mb, 250 mb and 100 mb levels that depict weather conditions at higher altitudes.

5.2.2.11 FDs

AES also has access to the upper level wind forecasts. On TABS these are organized along popular routes. AES has information about wind conditions at more geographical points.

5.2.2.12 Cross-sections

This information is not directly available on AES, though it can be derived by AES presentation technicians.

5.2.2.13 Notams

AES presentation technicians generally do not have access to this information.

5.2.3 Information available from FSS

The information available from the FSS system is quite similar to that available from TABS, although the accuracy study conducted by AES on TABS suggests that updates are available on the FSS system before they appear on the TABS system. Presented below is a list of the TABS pages and a brief comment indicating the availability of that type of information on the FSS information system.

5.2.3.1 Sigmets

Available.

5.2.3.2 Surface analysis and prognosis

These charts are not routinely available to the FSS.

5.2.3.3 FAs

The Canadian FAs are available. Getting the American FAs is a problem.

5.2.3.4 VFR/IFR analysis and prognosis

Not directly available but can be derived.

5.2.3.5 Pireps

Similar to TABS.

5.2.3.6 SA/FTs

Available.

5.2.3.7 SD

Available.

5.2.3.8 Radar

Not available.

5.2.3.9 850 and 700 mb charts

Not directly available.

5.2.3.10 FDs

Available, usually up to 18,000 feet.

5.2.3.11 Cross-sections

Not directly available but can be derived.

5.2.3.12 Notams

Available.

5.3 Pilots

Pilots vary widely in their qualifications, their flying experience, and their knowledge of meteorology. Table 5 shows the number of pilots in Canada with different types of licenses as of 1982, and restrictions on the licenses in terms of the plane weight and whether they can be paid for carrying passengers. The types of licenses in table 5 are ordered, beginning with the highest qualification and finishing with the lowest, the student pilot permit.

Number of pilots in Canada with different license types and restrictions on them

License Type	Number of of Pilots	Restriction on plane weight	Payment for passengers
ATC - Air Transport Rating	6,235	none	yes
Sr. Com - Senior Commercial	1,360	44,000 lbs.*	yes
CPL - Commercial Pilot License	8,500	12,500 lbs.**	yes
PPP - Private Pilot License	41,000	4,000 lbs.	no
SPP - Student Pilot	?		no

Table 5

In addition to the various licenses, pilots can obtain ratings. These include a night rating that permits pilots to fly at night and an IFR (Instrument Flight Rule) rating that permits a pilot to fly an appropriately equipped aircraft under conditions of poor visibility requiring instruments. An instrument rating requires a minimum of 150 hours as a pilot-in-command, passing a written and practical examination, and is renewed annually.

Pilots with higher license qualifications are more likely to have the ratings described. For example, every pilot with an Air Transport Rating has an IFR rating, but only 1% of those with private pilots license have an IFR rating.

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* For example, a jetliner.

** For example, a Twin Otter.

5.3.1 <u>Pilots' objectives when using weather information systems</u>

There are a number of different reasons for a pilot to use a weather information service. Although we do not yet have a complete understanding of the pilots' objectives, it is clear that pilots want different types of weather information. Sometimes pilots want a <u>preliminary briefing</u>, a general indication of weather conditions, that will allow them to decide whether they should plan to fly. On other occasions, pilots want <u>partial weather information</u>, perhaps because they already have a general idea of the weather from a previous phone call and only need to know whether the weather conditions have changed.

When pilots want a full route briefing, they get from FSS a structured briefing which has the following format. First, the pilot tells (with prompting from the briefer) whether he or she is VFR/IFR and describes the proposed flight -- the destination and alternate destination, the altitude, the aircraft, estimated departure and arrival times. With this information, the briefer can determine the pilot's weather information needs and determine what information is relevant to the planned flight.

The briefer begins by previewing the specific weather factors that will affect the flight (e.g., icing, turbulence, etc.). Then the briefer describes the latest weather conditions, the forecast weather conditions, types of clouds and other weather conditions to expect locally, en route, and at the destination and alternates. Following that, the briefer describes the terminal forecasts and hourly weather reports and indicates wind conditions. Finally, there is a summary highlighting the significant weather conditions. The information in a structured briefing, and the

order in which it is given, resembles the briefing pilots get when they get a structured briefing using TABS (option 1 on the Welcome page). However the FSS briefer can be more selective in presenting this information because he knows about the pilot's qualifications and planned flight.

Occasionally pilots want an area briefing to find out about weather conditions for a geographical area, not just for a particular route. For example, private pilots sometimes request an area briefing so that they can plan to fly where the weather conditions are forecast to be good. Also, companies doing aerial survey work will request area briefings in order to do surveys under clear skies.

Pilots who are learning to fly make fairly frequent use of the weather information services to determine weather conditions for a hypothetical flight. Thus, in some cases, these services are used as a training aid.

Occasionally, AES will get requests that require long-term weather forecasts from commercial firms planning their activities or even from a private pilot planning a winter trip to Florida.

The FSS reports that about 10% of their calls are for notice to airmen and about 20% are calls from pilots wanting to file their flight plans.

5.3.2 Knowledge of meteorology

At this point we do not have detailed knowledge about the meteorological knowledge of pilots, but it is clear that there is considerable variability across pilots. Those pilots with higher licence qualifications have

usually taken more courses on meteorology and for this reason are likely to be more knowledgeable about meteorology.

There is concern among our informants that some pilots, particularly some with a private license, have an inadequate knowledge of meteorology. This may include difficulties reading and interpreting weather maps, particularly for the less experienced pilots who have received little training. However, adequately trained pilots find maps easier to understand than verbal descriptions of maps which a pilot gets when using the FSS or AES phone service. Our informants indicated that there were a number of reasons why knowledge of meteorology is so low. These include:

- The qualifying examination is currently structured so that it is possible to fail all the questions on meteorology and still obtain a license. In the near future pilots will have to answer correctly a minimum number of questions in meteorology in order to pass the examination.
- There is reason to believe that some instructors do not have a good understanding of meteorology, and therefore pilots learning from these poorly qualified instructors do not learn much about meteorology.
- In some cases it has been many years since pilots received instruction in meteorology. This problem is more serious when the private pilot owns the aircraft because it is possible for him to fly without having flown in a year. Flying clubs or services that rent planes have a requirement that unless the pilot has flown recently (e.g., within the last 30 days) he must fly with an instructor before he can rent the

plane. Even with this rule, it may be possible for a pilot to rent a plane without demonstrating adequate knowledge of meteorology.

5.3.3 <u>Attitudes of pilots toward the three weather information services</u>

Based on interviews with individuals who are in close contact with pilots, we learned that many of the newly graduated pilots do not like the subject of meteorology. Some of these pilots find it frustrating to get weather information because it is difficult to complete a telephone call to an AES or FSS briefer. The telephone busy studies confirm this finding. In addition, some of the less experienced pilots find it difficult to understand the weather information when it is quickly given over the phone by a briefer.

It was the feeling of our respondents that the less experienced pilots may prefer to get weather information from TABS compared to an FSS or AES telephone briefing because:

- pilots can take as long as they like with TABS compared to the other services
- pilots can use their manuals and the HELP pages to look up the meaning of a symbol or an abbreviation
- many pilots find it easier to understand a weather map than a verbal description of a map.

It was felt that more experienced pilots would use TABS, in conjunction with a complete weather briefing by AES or FSS.

There seemed to be general agreement that all pilots prefer an in-person briefing by FSS or AES because:

- maps can be used to illustrate points made by the briefer
- pilots believe that briefers generally have more time and are more willing to answer questions
- pilots in the vicinity can hear other pilots being briefed. From these pilots they can hear other questions being asked (that they might not have considered) and answered.

5.4 TABS terminal sites

Usage of the TABS terminals varied widely from site to site. Table 6 shows the minimum, maximum, and average number of sessions for a one hour for the month of October 1984. The most heavily used terminal was located at Brampton, where there were an average of 58 sessions a day for the month of October, or slightly less than 2 (58/31 = 1.87) sessions per hour for a single day. At its busiest, Brampton has about 3 sessions per hour in a day, so overcrowding does not appear to be a problem. Inspection of the table also shows there is large variability in use from location to location. Average use varied from 58 sessions per day at Brampton to 7 sessions at Downsview.

Range and average daily usage of TABS at different airport sites

Airport	Min.	Max.	Average
Brampton	8	93	58
Burlington	0	25	15
Buttonville	2	60	29
Downsview	0	16	7
Guelph	1	34	19
Hamilton	2	17	9
King City	0	16	8
London	4	29	15
Maple	0	26	16
Markham	0	16	9
Pearson	0	31	13
- Avitat	7	30	17
- Innotech	9	27	20
- Skycharter	3	29	9

Table 6

5.4.1 Usage of TABS

Table 7 indicates the "popularity" of the different TABS pages. It shows for each TABS page the percentage of time that page was accessed during October 1984. This table indicates that there are differences in the frequency with which the different pages were accessed. However, it is somewhat difficult to make comparisons across pages because 1) for the SA page, access to each separate SA area was counted as a page hit. No other page was treated this way; 2) the page hits include access to the pages retrieved by pilots freely and those that are retrieved as part of a structured briefing. The right-most column of table 7 indicates which pages are included in a structured briefing; and 3) TABS is structured so that pilots are automatically presented the Sigmet page whenever a new sigmet enters the TABS data base.

Percentage of page hits for the different TABS pages

Keyword	Page Name	Percentage of Page hits	Present in structured briefing
WS	Sigmet	14	yes
SA	Aerodrome surface weather*	24	yes
FA	Area forecast	4	yes
FD	Upper level wind forecast	3	no
UA	Pireps	3	yes
XSC	Cross-section	5	no
SD	Radar (text)	2	no
RAD	Radar (screen)	5	no
SFCP	Surface prognosis	6	yes
850M	850 mb	1	no
700M	700 mb	1	no
SFCA	Surface analysis	7	yes
HELP	Help	4	no
VFRP	VFR/IFR prognosis	4	yes
VFRC	VFR/IFR current	4	yes
FA0	Area forecast (current)	4	yes
FA12	Area forecast (t + 12)	4	yes
NOT	Notams	4	no

Table 7

Table 8 shows how usage of TABS varies with the time of day. Usage is highest from 8 a.m. until about 2 p.m. and drops off in the late afternoon and evening. These results are similar to findings obtained in the FSS busy study and indicate that TABS, like the other weather information services, will experience substantial hourly variations in demand.

The TABS usage data were also examined to determine to what extent usage varied with the day of the week. Results of this analysis indicated that usage did not vary much from day to day. TABS was used most on Thursday, receiving 16% of the weekly activity, and used least on

* Each SA area request is counted separately.

Tuesday, receiving 12% of the week's activity.

The column on the right of table 8 shows the average time interval in seconds from the end of a response from a terminal to the beginning of a response from the TABS computer system. These results indicate that response time increases with increases in usage slightly from 100 to 200 milliseconds.

Percentage of page hits and average response time for each hour of operation

Time of Day	Percentage of page hits	Average response time (sec.)
6- 7	5	.1
7- 8	7	.2
8- 9	10	.2
9-10	9	.2
10-11	9	.2
11-12	10	.2
12-13	8	.2
13-14	10	.2
14-15	8	.2
15-16	7	.2
16-17	5	.2
17-18	4	.2
18-19	3	.2
19-20	3	.1
20-21	3	.1

Table 8

5.4.2 Description of airports

To better understand the environment in which TABS is used and the type of people using it, site observations were made at four airports with TABS terminals -- Buttonville airport, Maple Flying Services, King City Flying Club, and the Toronto Island Airport. These airports differ in the size of their operation and the way in which TABS is being used.

At the Toronto Island Airport, despite four visits over several weeks we were unable to use the TABS terminal. The problem seems to be with the terminal and its connection to the computer. The failure of the terminal suggests that there is a need for a better mechanism for ensuring that the terminals are working. Because the terminal was never in working order we did not continue with the inspection of the Toronto Island airport site and for this reason it will not be further described.

Buttonville Airport is a large multi-use airport. It has a flying school with about 450 students at any given time. It offers a variety of courses which include VFR, IFR, night flying, and the use of multi-engine aircraft. The airport is controlled and there is a scheduled airline (Torontair) which uses Buttonville as its home base.

Maple Flying Services is a medium-sized airport. There is a flying school with 250 to 300 students who can receive VFR and multi-engine training. Students wanting to obtain IFR are referred to Buttonville. The airport is uncontrolled. Maple operates a charter service based at Pearson International Airport.

King City is a small flying club. There is a flying school which offers VFR training courses to about 30 students. The airport is uncontrolled.

5.4.3 Location and use of TABS

At Buttonville the terminal was located in the pilots' room on a desk having a chair. There was plenty of space for writing. On the day of the site visit the terminal was being used by a student pilot who was making notes. Help in using TABS is available from other pilots and

instructors.

At Maple, the terminal was located in the main club house near the door on a desk with a chair. There was no writing space. On the day of the site visit the terminal was operational but not in use. However, the weather was bad and very few pilots were there. Assistance in using TABS is available from other pilots and instructors.

At King City, the terminal is located in the main club house on a desk with a chair. There is plenty of space for writing. On the day of the site visit, the system was not working because of problem with the terminal. Other pilots and instructors are available to pilots wanting to use TABS.

5.4.4 Purpose of TABS usage

At Buttonville we were told that it was best suited for the less qualified pilots, as preparation for a phone call to AES or FSS for a full weather briefing.

At Maple everyone including instructors uses TABS as an alternative to phoning AES or FSS. Phoning, using the airport's direct lines to Toronto, is discouraged because it ties up charter-booking lines.

King usage is similar to Maple's. Everyone uses TABS as an alternative to phoning AES and FSS.

5.4.5 Encouragement of TABS use

At all three airports TABS is used in instruction. At Buttonville use of TABS as preparation for a full weather briefing is encouraged, whereas at Maple and King City TABS is used as a sole source of weather information.

5.4.6 <u>Use of weather information services before TABS</u>

At Buttonville we were told that before TABS, attempts were made to call the weather office, or get some idea about weather, if only from someone else who had talked to the weather office.

At Maple and King City we were told that pilots "do not normally" call the weather office because most flights are "local".

6.0 Conclusions and identification of information gaps

1 - There is a real need for a weather information service for pilots. The busy studies conducted on the FSS and AES phone service confirmed reports by pilots who complained about the difficulty in getting through to a weather briefer. We need to find out to what extent TABS can effectively supplement those services to meet this demand.

2 - The three weather information services investigated all appear to provide the same basic weather information. Each service also has unique features. The AES phone-in service seems especially well suited for pilots and others needing unusually detailed or extensive weather information. The FSS phone-in service is especially useful for pilots who have transportation-related needs such as filing flight plans or getting detailed information about airport facilities. TABS has been designed as a convenient way for pilots planning short-distance flights in southern Ontario to obtain needed information. TABS has a number of unique features. These include: 1) Pilots can proceed at their own rate using TABS. They can review previously presented material, look up the meanings of symbols and abbreviations and not feel self conscious because they are interacting with a machine not a briefer. 2) Pilots can look at maps and graphs using TABS. Pictoral information may make it easier for pilots to understand the weather conditions.

TABS is being used in other ways to supplement existing weather services. Some pilots use it for training purposes and to

plan hypothetical flights. Others use TABS to get a preliminary briefing before phoning one of the other services for a full route briefing. TABS also supplements the phone-in services by providing a backup if pilots cannot reach a briefer by phone.

3 - There is concern about the accuracy and especially the timeliness of the information on the TABS data base. This is a serious matter because of its safety implications; it also may reduce confidence in the service.

It is our understanding that work is currently underway to determine whether this concern is justified. In our view this work should investigate updating of TABS and obtain detailed information about the frequency and nature of the update delays. This information could then form the basis of a channel-node analysis. In this analysis, data that eventually end up in the TABS data base, are followed from their source to their destination and the time it takes for the data to go from one node to the next is measured in order to identify the bottlenecks in the transmission of the data.

4 - In some cases there have been problems keeping the terminals operational at the airports. This problem has already been identified by the Ministry of Transportation and Communications which has hired a private-sector firm to service the terminals.

5 - All weather information services appear to experience considerable variability in demand. Demand varies from hour to hour, from day to day, and even from season to season. Factors influencing demand for the service include people's travelling habits and weather conditions. This variability makes it desirable to design and

manage a system that can respond to variations in demand in a flexible, but cost-effective manner.

6 - Weather information services should give pilots the information they need quickly. We learned that most phone calls between briefers and pilots are short. Few calls last more than 10 minutes and most last less than 4 minutes.

7 - Pilots use weather information services for a variety of reasons. These include: training, route briefings (most frequent), preliminary briefings, weather updates and area briefings. Each reason requires different information. Thus, weather information systems need to be sufficiently flexible so that pilots can obtain needed information efficiently.

8 - There is wide variability in the experience and qualifications of pilots. This variability appears to affect the nature of the interaction between the pilot and the system. It will be important to determine if TABS can meet the needs of highly expert and well qualified pilots as well as novice pilots.

9 - Our interviews indicate that most pilots do not find it very difficult to use the TABS terminals. Rather the problems of pilots may center around their inability to understand the weather information they are being presented and appreciate its relevance to their planned flight.

10 - We know very little about the pilots who currently use the system. Most of our informants expect that inexperienced pilots will find the TABS system particularly useful. On the other hand, the user survey of TABS was completed most often by highly qualified and

experienced fliers, and only infrequently by inexperienced pilots. Although this result may reflect a limitation in the survey methodology, it may reflect a tendency for TABS users to be relatively more experienced pilots.

11 - We began our investigation by trying to find information that would tell us who is using the TABS and how they feel about the different weather information systems. Although at this point we have a considerable amount of information about the weather information systems and how they work, we still do not know who uses TABS and what their reactions are to various weather services.

12 - We also wanted to learn about the performance of pilots when using TABS. Do pilots thoroughly and accurately understand and remember weather conditions after briefing themselves using TABS? At this point, we cannot answer this question.

7.0 References

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